Device comprising a solar cell arrangement and a liquid crystal display

Description

The invention relates to a device comprising a solar cell arrangement and a liquid crystal display according to the introductory clause of claim 1 and a method for manufacturing such a device as well as a possibility of application.

Solar cell arrangements, namely single solar cells as well as arrangements – so-called modules made of several or a plurality of individual cells interconnected to each other – are known from prior art in a great number of modifications. Liquid crystal displays or so-called LCD's are also known in various embodiment versions. Solar arrangements and LCD's are commercially obtainable as separate components for different employment purposes.

It has also been known for some time to employ a solar cell arrangement as an energy source for a timepiece, especially a wristwatch. It is furthermore known to use liquid crystal displays to show the time of the day, the date or the like.

The majority of wristwatches are equipped with a dial train displaying time in an analog manner. For this purpose, the solar cell arrangement of a wristwatch of the aforementioned type serving as energy source is usually designed in the form of a dial face. An aforementioned LCD to show the date or other special functions is inserted into

this dial face in many of these solar-powered wristwatches known as solar wristwatches. The solar dial faces and the LCD's are separate components in solar wristwatches of this type whereby said components are usually arranged being stacked on top of one another.

A "tunnel impression" in reading the LCD arranged behind a so-called data window is a disadvantage in such a stacked arrangement.

The invention has now the object to provide a device comprising a solar cell arrangement and an LCD making new display possibilities and effects possible in stacking the two optical elements, namely the solar cell arrangement and the LCD.

This object is achieved through a device comprising a solar cell arrangement and an LCD having the characteristics of claim 1.

Advantageous embodiments and developments of the invention are shown in the minor claims.

The invention is generally based on solar cell arrangements and LCD's of known types. Solar cell arrangements in the form of stacked arrangements are provided at least with one at least partially transparent carrier for one or several solar cells, which can be possibly interconnected to one or several modules. Each solar cell includes again at least one photovoltaically active layer embedded between one at least partially transparent contact and one metallic contact, as a rule.

Those skilled in the art are aware that the above-mentioned solar cell structure can include a plurality of such stacked arrangements disposed on top one another; so-called multi-junction arrangements are included as well, in particular.

Glass is usually used as carrier material of so-called thin-film solar cell arrangements, i.e. the ones in which the photovoltaically active layer is amorphous silicon. However, synthetic materials, ceramics or the like are also considered as carrier material.

In case of solar cell arrangements having crystalline materials as a photovoltaically active layer, such as crystalline silicon, for example, this crystalline material can take on the function of the carrier itself.

The LCD used in the invention is provided in its stacked arrangement with at least one first polarizer, an at least partially transparent carrier, a first contact being at least partially transparent, a liquid crystal, a second transparent contact, a second transparent carrier, a second polarizer and a reflector.

The main concept of the invention is to combine the solar cell arrangement and the LCD into one single component, which has had separate individual components up to now, and to combine them preferably in such a manner that the optical planes of the photovoltaically active layer and of the LCD are essentially in the same plane. This is

realized according to the invention in that one carrier of the LCD serves as carrier for the solar cell arrangement.

In principal, the LCD can be disposed below or above the solar cell arrangement or within an opening in the solar cell arrangement as well. The solar cell arrangement, or parts thereof, can thereby also assume functions of parts of the LCD (or vice versa) so that the total structural height is significantly reduced.

It is proposed in a first variant of the invention that the carrier of the solar cell arrangement if the first carrier of the LCD. The LCD lies in this case underneath the solar cell arrangement. In the simplest case, the solar cell arrangement and the LCD are arranged adjacent to each other but are laterally separated from one another. The solar cell arrangement and the LCD are in this case almost completely uncoupled. However, it is also possible that the solar cell arrangement and the LCD overlap each other laterally at least partially.

It is of advantage in the firstly mentioned embodiment version to use the transparent contact of the solar cell arrangement also as a first transparent contact of the LCD – or inversely, to use the first transparent contact of the LCD also as a first transparent contact of the solar cell arrangement in order to save space in structural height, on the one hand, and to keep as low as possible the number of processing steps in the manufacturing of such devices having a solar cell arrangement and an LCD, on the other hand.

It is of advantage for the second version, which is the at least partially overlapping arrangement of solar cell arrangement and LCD, to design the solar cell arrangement to be at least partially semi-transparent. The solar cell arrangement is preferably designed only in this overlapping area to be semi-transparent. Such overlapping offers new display possibilities and effects for the two optical elements.

Two embodiment examples of the invention are illustrated in the drawings and they are described in more detail in the following:

FIG. 1 shows in cross section a first embodiment version of a solar dial face of a watch having an LCD arranged according to the invention.

FIG. 2 shows a basic design of a solar cell according to the state-of-the-art.

FIG. 3 shows a basic design of the LCD according to the state-of-the art.

FIG. 4 shows in cross section a second embodiment version of a solar dial face of a watch having an LCD arranged according to the invention.

FIG. 5 shows a basic design of a solar cell according to the state-of-the-art.

The first embodiment version of a solar dial face of a timepiece sketched in FIG. 1, particularly a wristwatch, is provided with a solar cell arrangement 1 as well as an LCD 2

of generally known type. FIG. 2 and FIG. 3 show the basic design of a solar dial face as well as of an LCD 2 according to the state-of-the-art as they are currently employed.

The solar dial face is a single solar cell 1 in its structure in the present embodiment example. Those skilled in the art take it for granted that the solar dial face can also be formed by a plurality of such single cells, which can be interconnected in a corresponding manner (possibly directly on the substrate as well.)

The solar dial face consists in the present case of a transparent carrier 4 made of glass onto which there are applied the transparent (front) contact 5 made of transparent conductive metal oxide (TCO = transparent conductive oxide), the photovoltaically active layer 6 made of amorphous silicon, and the (rear) contact 7 made of metal. The three layers consisting of a transparent contact 5, a photovoltaically active layer 6 and a contact 7 are removed forming an opening 8 in the area of the (data) window 3.

The LCD 2 consists of the active liquid crystal 11, which maintains contact through two transparent carriers 9, 10, which are coated with TCO and glued to one another, two polarizers 12, 13 and one reflector 16. The dual TCO coatings representing the transparent contacts are identified in the drawing with the reference numbers 14 and 15, and the adhesive bond is identified with the reference number 17a. It must be pointed out that the TCO layers having a structured texture (corresponding to the indicating numerals) are drawn as a smooth surface for the sake of simplification.

The illustration in FIG. 1 shows the combination of the two elements described above with the solar cell 1 and the LCD 2 representing the solar dial face in such a manner that the transparent carrier 4, the substrate glass, and solar cell 1 take on, at the same time, the function of the first transparent carrier 9, which is called in professional terms also as a LCD cover glass. The optical planes of the photovoltaically active layer 6 and of the LCD 2 fall together in this structure. This means in concrete terms that the numerals of the LCD 2 appear in the same plane as the (data) window 3.

The above-described embodiment version of a solar dial face (solar cell 1) of a watch having an LCD 2 can be manufactured as follows:

The solar cell 1 has to be manufactured at first since its necessary processing temperatures could damage the liquid crystal 11 and thereby the LCD 2 as well. The (data) window 3 is subsequently opened. Should only the metal of the contact 7 and the photovoltaically active layer 6 removed in that area, then the transparent contact 5, the TCO layer, and the solar cell 1 can be constructed correspondingly and used to maintain contact with the fluid crystal 11. However, it is also possible to apply in this area an additional TCO layer as transparent contact 40. The adhesive bond 17b with the second transparent carrier 10 is outside the viewable area, which is defined by the opening 8 in the photovoltaically active layer 6. Finally, the first polarizer 12 is applied on top of the solar cell 1 representing the solar dial face.

A second embodiment version of a solar dial face produces in a similar manner a watch having an LCD 3 arranged according to the invention as shown in FIG. 4.

The basic elements are similar to the ones in the aforementioned embodiment example and they are a thin-film solar cell 1 and an LCD 2 according to the state-of-the-art as they can be seen in FIG. 5 and FIG. 3. The version illustrated in FIG. 4 differs from the above –described embodiment version only in the fact that not all three layers were removed in the area of the (data) window 3 of the solar cell 1 forming the solar dial face, whereby said layers are namely the transparent contact 5, the photovoltaically active layer 6 and the (metal) contact 7 – but removed were only the usually non-transparent (metal) contact 7. Should the photovoltaically active layer 6 be designed now to be semi-transparent, then there are created in this way new display possibilities and effects by stacking on top of one another the two optical elements, which are the solar cell 1 and the LCD 2.

Reference index

1	solar cell
2	liquid crystal display
3	display window
4	transparent carrier
5	transparent contact
6	photovoltaically active layer
7	contact
8	opening
9	first transparent carrier
10	second transparent carrier
11	liquid crystal
12	first polarizer
13	second polarizer
14	first transparent contact
15	second transparent contact
16	reflector
17a, 17b	adhesive bond
18	display area